Synopsis

For Pre- Ph.D. Registration

on

Floristic Composition and Phytosociological studies of Lohardaga District, Jharkhand using Geospatial Technology

Submitted by:

Alice Bably Khalkho

[M.sc Botany]

(Qualified R.U. Ph.D. Entrance, Exam Roll No.: 03057)

University Department of Botany

Ranchi University, Ranchi

Under the Supervision and Guidance of

Dr. Prasanjit Mukherjee

Head, Department of Botany

K.O. College, Gumla

(A constituent Unit of Ranchi University, Ranchi)

In

University Department of Botany

Ranchi University, Ranchi

[Faculty of Science]

2025

STATE-OF-THE-ART: The still reflect the floristic composition as well as phytosociological analysis, i.e., Frequency, Density, Abundance, IVI, Shannon Diversity Index, Evenness index, Similarity index etc., through geospatial techniques.

The State Jharkhand came on the map of India on 15th November 2000 by carving out of territories of Bihar through enacting the Bihar Reorganization Act 2000. Based on geomorphological features, Jharkhand can be divided into North and South Jharkhand, the Damodar Valley, the Santhal Pargana uplands, the Patland region, the Ranchi Plateau, and the Singhbhum region[30].Lohardaga district, located in the State of Jharkhand, India, is characterized by diverse flora and rich vegetation. This study aims to analyze the region's phytosociological structure and floristic composition using GIS (Geographic and Information Systems) and remote sensing technologies. These advanced tools will enable comprehensive spatial analysis and mapping of vegetation patterns, which are crucial for biodiversity conservation and sustainable management.

The classification of forests and forest types, according to H.G Champion and S.K. Seth, as presented in their work "A Revised Survey of the Forest Types of India" (1968), is one of the most comprehensive and widely used systems for categorizing Indian forests[6]. They stated that there are 16 main categories of forest. The Jharkhand state is rich in forests and mineral wealth, and as per the Champion and Seth classification of the forest Types (1968), the forest in Jharkhand belongs to two Forest Type Groups, which are further divided into eight sub-forest types. According to the Indian State of Forest Report (2019), Based on the interpretation of IRS Resourcesat-2 LISS III Satellite data of the period Nov 2017 to 2018, the Forest cover in the State is 23,611.41 sq km, i.e., 29.62% of the total geographic area[19].

Phytosociological studies generally provide insight into ecosystems' structure, composition, and dynamics. And by understanding how plant species interact and coexist, phytosociologists can uncover patterns of Biodiversity, species dominance, and ecological balance. Phytosociological is the study of plant communities with regard to their component structure and classification, including species diversity, growth trends of succession etc., and an observation of phytosociological characteristics is one of the basic requirements to estimate the current status of forest resources, Chauhan et al. (2012)[7]. Traditional methods in phytosociological surveys involve extensive field surveys, often employing quadrat and transect sampling techniques to gather data on species presence, abundance, and cover. These methods are essential for assessing species diversity, dominance, and distribution patterns.

Studies in regions similar to Lohardaga have typically revealed intricate patterns of plant community dynamics influenced by factors such as soil type, topography, and climate. In a study done in the Hazaribagh and Latehar districts, two big districts of Jharkhand, the forest type was found to be primarily heterogeneous, with *Shorea robusta* as the dominant species. And the high Importance value index shows that it is quite dominant over other species with high regeneration power[10]. Floristic composition studies provide a detailed inventory of plant species within a specific area, focusing on species richness, diversity, and distribution. These studies are crucial for understanding the ecological balance and potential conservation priorities. Floristic study of Jharkhand has been studied back to the year 1848-1851 during the time of J.D. Hooker and T. Thomson, and their work was published in "Flora Indica" (1855) and later revised as "British India" (1972-1897). Floristic composition, which involves cataloguing and analyzing the variety and abundance of plant species in a given area, is fundamental to biodiversity studies. This information is essential for assessing ecosystem health, guiding conservation efforts, and informing land management practices.

Remote Sensing (RS) and Geographic Information Systems (GIS) are very powerful, feasible, and cost-effective tools in forest mapping, quantitative assessment, vegetation classification, and natural resource management[31]. Different multispectral imageries with GIS maps are considered add-on tools for conserving and managing natural resources [13]. Remote sensing is mainly concerned with ecosystem-level properties of vegetation, for instance, biomass, productivity, and LAI ,Jasinski, 1990[21]; Todd & Hoffer, 1998[34]; Tucker and Sellers, 1986[35]; Friedl et al., 1994[14], or deals with preparing physiognomic maps of plant cover used principally in assessing landscape change, Huete et al.[18]; Harvey & Hill[16]; Borfecchia et al.[8]. Although examples of remotely sensed phytosociological maps are not very numerous, supervised phytosociological interpretation of satellite images is nonetheless an already grown-up field of research [11].

However, very few studies have been conducted on phytological and floristic composition and vegetation in the Lohardaga forest area, which is also equally vital to call for immediate and timely scientific interventions to support the conservation of this natural forest. Hence, the current study aims to study the nature of vegetation and the floristic composition of the Lohardaga district, which can help identify the district's phytological rich zone.

PROBLEM TO BE INVESTIGATED

- There is a need for standardized and robust methodologies for data collection and analysis to ensure accurate and reliable results in vegetation studies.
- Lack of comprehensive information of the native flora of the District.
- Monitoring and protecting Biodiversity is difficult due to lack of proper data.
- The conservation status and presence of rare, endangered, and endemic plant species are poorly documented.

OBJECTIVE OF THE INVESTIGATION AND MOTIVATION

Objectives -

1. To study the Floristic composition and their identification.
2. Phytosociological analysis of the Study area. (Frequency, Density, Abundance, IVI, Shannon Diversity Index, Evenness index, Similarity index, etc.
3. To study the species gradient along elevation using Geospatial techniques.
4. Species mapping (Representation of Species through Map).
5. Comparison of findings with previous work done, from authentic sources.

Motivation-

The motivation for this study arises from the need and conserve the underexplored biodiversity of Lohardaga district of Jharkhand, which is a home to wide variety of plant species. And currently there is a lack of comprehensive data on the floristic composition and vegetation dynamic of the district. More over the traditional methods of studying plant communities do not use modern tools that can enhance the precision and scope of ecological research. the integration of geospatial technologies like GPS and GIS can offer a new sight into the distribution of vegetation and impact of various environmental factors on biodiversity.

HYPOTHESIS

- The Floristic composition, i.e., the total flora of the area, will be known.
- The phytosociological studies will reflect the Frequency, Density, Abundance, IVI, Shannon Diversity Index, Evenness index, Similarity index etc., of the species available in the study area.
- The species gradient along elevation will be known.

RESEARCH DESIGN AND METHODOLOGY

1. Study area

Lohardaga district is situated in the western part of Jharkhand state of India and is characterized by diverse topography, vegetation, and climate. It spans an area of approximately 1,502 square kilometer, out of which approximately 504 square kilometer, which is 33.60 % of the total geographic area, is forest area. The region is known for its undulating terrain, dense forests, and varied climatic conditions. The district's vegetation includes tropical deciduous forests, sal forests, and patches of grasslands.

The district's geographical coordinates range from 23.4°N latitude and 84.68°E longitude. The district features a mix of hilly and plateau regions, with several small hills and undulating landscapes. The average elevation is around 647 meters (2,123 feet) above sea level.

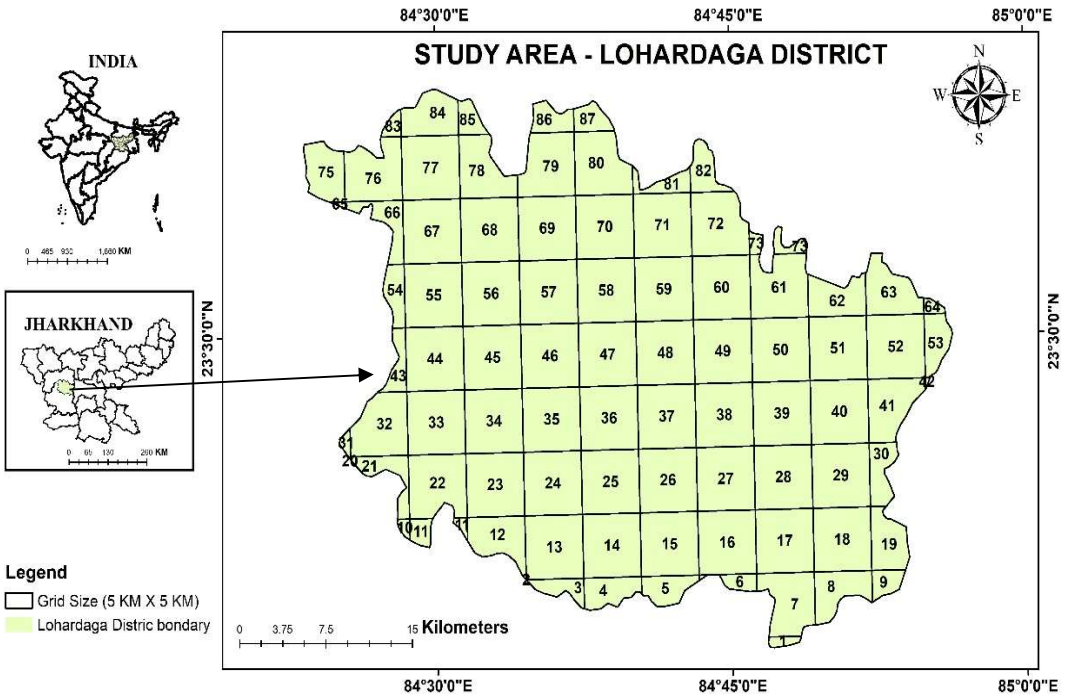

Figure 1 Study area map

Sampling design:

A total of approx. 261 quadrats, each of 0.1 ha (31.61 x 31.61m) in size, will be sampled in 87 grids of the Lohardaga district of Jharkhand to sample all trees (≥10 cm GBH). Shrubs and herbs were sampled randomly in one 5 m × 5 m quadrat and two 1 m × 1 m quadrats within the quadrats of trees.

Grid generation

Grid number systems adopted following the Survey of India (SoI) divide the Lohardaga district into 5km x 5 km with the help of remote sensing software (ArcGIS; *version* 10.3). Lohardaga district is covered by a total of 87 grids of 5 km x 5 km, including some areas adjacent to the district boundary. For vegetation sampling, one quadrat (31.6 m × 31.6 m) will be laid in each grid. Detailed statistics of grids and vegetation sampling are shown.

Table 1: Grid generation statistics and vegetation sampling details of Lohardaga district, Jharkhand, Eastern India.

The total geographical area of Lohardaga	:	1502 sq. km. (ISFR, 2021)
Total number of topographical sheets covered by Lohardaga district	:	(06) 73A/6, 73A/7, 73A/10, 73A/11, 73A/14, 73A/15
Total no. of girds covering Lohardaga District	:	87
District cover Forest type group (Based on champion and Seth classification)		Moist deciduous Tropical Forest (Group 3)
Forested area (Open, Moderately and Dense Forest)		504 sq. km.
Area of individual grid	:	5 × 5 km (25 sq. km)
The total number of quadrats (31.6 x 31.6 m) will be sampled.	:	87 X 3 = 261 (3 quadrats per grid)
Area of the quadrat for Tress		31.61 X 31.61 m =1000 (approx.) m^2 or 0.001 sq. km
Total area to be sampled in the study	:	261 X 0.001= 0.261 sq. km

Data Analyses

Quantitative analyses of vegetation will be performed following Misra (1968)[26]. The importance value index (IVI) is the sum total of relative density, relative frequency, and relative dominance for trees, and the same has been calculated by summing up the relative frequency and relative density for bamboo, shrubs, and herbs. Statistical analysis of data will performed using the statistical software package SPSS (*version* 20), Origin (2019), and Microsoft Excel (2021). Maps will be prepared with the help of QGIS (*version* 3.4.4) (Open source)

Remote sensed data used

The high-resolution satellite imagery provided by Google Earth and Sentinel 2A with a Multispectral Imager (MSI) sensor (freely downloadable worldwide) will be used for visual image interpretation and map preparation. DEM (Digital elevation model) data of high

resolution (30 m x30 m) (Space Shuttle Radar Topography Mission (SRTM), or ASTER Global Digital Elevation Model will be used to deduce topographical variability (Altitude, slope, and aspect) of the region. The Altitude was classified to six classes (<200, 200-300, >300-400, >400-500, >500-600, and > 600 m), and slope into five major classes (<4, 4-8, >8-12, >12-16, and > 16 degrees). Aspect can be thought of as the slope direction and was classified as Flat (F); North (N), Northeast (NE), East (E), Southeast (SE), South (S), West (W), Northwest (NW), and North (N).

Conclusion/Expected outcome

Phytosociological studies and floristic composition analysis, enhanced by geospatial technology, offer critical insights into the Bio diversity and ecological health of the Lohardaga district. These integrated approaches provide valuable data for conservation planning, resource management, and sustainable development. Further research in Lohardaga can focus on detailed species inventories, temporal changes in vegetation, and the impacts of anthropogenic activities and climate change on plant communities. Through the application of advanced geospatial techniques, a more holistic understanding of the region's ecological dynamics can be achieved, informing effective conservation and management strategies.

TOOLS TO BE USED IN THE COLLECTION OF DATA

Field survey tools- Quadrants, Measuring instruments, Plants identification tools (flora, field guide, keys)

Geospatial Tools – geographical information system(GIS) software like ArcGIS, QGIS or ERDAS.

Herbarium and laboratory tools

Online database – plant data base.

Analytical tools - Statistical software package SPSS (*version* 20), Origin (2019), and Microsoft Excel (2021). Maps will be prepared with the help of QGIS (*version* 3.4.4) (Open source).

SIGNIFICANCE OF STUDY

Present study will provide detail insight into species diversity, and the identification of biodiversity hotspot. The main significance of the study are:-

- Baseline data generation for the future ecological study.
- For holding the regional importance and contributing in the broader study of Indian biodiversity.
- The study can prioritize conservational efforts.
- The study will provide valuable information for policymakers in Policy formulation for effective conservation of the environment.

ITS RELEVANCE WITH THE PRESENT DAY PROBLEM AND NEED OF THE SOCIETY

- The districts of Jharkhand state are very rich in biodiversity therefore understanding the detail biodiversity composition is essential for preserving our ecological balance and also for the conservation of some rare and endemic plants species.

- And with little advancement in taxonomical studies, such as use of GIS, GPS and remote sensing technologies, it is now possible to analyze large vegetation data accurately, making this study more relevant in the modern scientific context.

- Apart from the ecological significance this study directly benefits our society by promoting sustainable resource management. lohardaga forests are source of livelihoods particularly for indigenous communities reliant on forest product like medicinal plants, fuelwood and fodder. By identifying and preserving valuable plant species the study supports these communities while ensuring long term availability of all these resources.

CONTRIBUTION TO THE EXISTING KNOWLEDGE

Phytosociological studies have been conducted for classification of vegetation type and documenting plant species in India. Phytosociological studies like those were conducted by Champion and Seth [6], which classified the vegetation type across India. While the existing studies provide broad overview, this study will make some significant contributions to the existing knowledge especially in the field of ecology and biodiversity by focusing on the Lohardaga district that is rich in biodiversity but is underexplored. The research will provide a comprehensive floristic inventory and phytosociological analysis. This study will document the, abundance and species distribution, potentially identifying lots of rare, endemic species that are yet to be recorded.

Remote sensing and GIS have been widely used for vegetation mapping and land use change analysis. The use of remote sensing and GIS will showcase their potential for large- scale

ecological studies. And thus the use of GIS technology will enhance the precision and scope of ecological study.

FUTURE WORK

This study can pave the way for further research and practical application in the field of ecology, plant taxonomy, conservation and sustainable resource management such as,

Ecological restoration

Contribution in the development of flora

Long term monitoring of the biodiversity of the area

Recommendations for the policy making

REFERENCES

1. Abousaeidi, M., Fauzi, R., & Muhamad, R. (2016). Geographic Information System(GIS) modeling approach to determine the fastest delivery routes. *Saudi Journal of Biological Sciences*, 23(5): 555-564.
2. Ayyappan, N., & Parthasarathy, N. (1999). Biodiversity inventory of trees in a large-scale permanent plot of the tropical evergreen forest at Varagalaiar, Anamalais, Western Ghats, India. *Biodiversity and Conservation*, 8(11): 1533-1554.
3. Bhatt, G. D., Kushwaha, S. P. S., & Bargali, K. (2014). Remote Sensing and GIS tools used to analyse the Floristic diversity in South Gujarat. *Remote Sensing*, *3*(12): 18165-18176.
4. Borfecchia, E., Beato, P., Svelle, S., Olsbye, U., Lamberti, C., & Bordiga, S. (2018).Cu-CHA–a model system for applied selective redox catalysis. *Chemical Society Reviews*, *47*(22): 8097-8133.
5. Braun-Blanquet, J., Fuller, G. D., & Conard, H. S. (1965). Plant Sociology: The Study of Plant Communities. Hafner, London.
6. Champion, H. G., & Seth, S. K. (1968). A Revised Survey of Forest types of India. Govt. of India, New Delhi, pp. 103-404.
7. Chauhan, B. S., Singh, R. G., & Mahajan, G. (2012). Ecology and management of weeds under conservation agriculture: a review. *Crop Protection*, *38*: 57-65.
8. Dash, C. J., Adhikary, P. P., Madhu, M., Mukhopadhyay, S., Singh, S. K., & Mishra, P.K.(2018). Assessment of spatial changes in forest cover and deforestation rate in Eastern Ghats Highlands of Odisha, India. *Journal of Environmental Biology*, 39(2): 196-203.
9. Dengler, C., & Strunk, B. (2018). The monetised economy versus care and the environment: degrowth perspectives on reconciling an antagonism. *Feminist Economics*, *24*(3): 160-183.
10. Divakara, B. N. (2016). Floristic analysis, phytosociological studies and regeneration status of tree species in Sal forests of Jharkhand, India.

11. Fanelli, F., Bianco, M. P., D'ANGELI, D., De Sanctis, M., SAULI, A. S., Testi, A., & Pignatti, S. (2005). Remote sensing in Phytosociology: The map of vegetation of the Provincia of Rome. *Annali di Botanica*, *5*: 173-184.
12. Fanelli, G., Pietro, M. B., Cazzagon, P., D'angeli, D., De Corso, S., De Sanctis, M., ... & Pignatti, S. (2005). Remote Sensing In Phytosociology: The Map Of Vegetation Of The Rome Provincia. ANNALI *DI BOTANICA nuova serie 5:1-14.*
13. Freeman, P. H., & Fox, R. (1994). Satellite mapping of tropical forest cover and deforestation: A review with recommendations for USAID. Arlington, VA: Environment and Natural Resources Information Center, DATEX.
14. Friedl, M. A., Schimel, D. S., Michaelsen, J., Davis, F. W., & Walker, H. (1994). Estimating grassland biomass and leaf area index using ground and satellite data. *International Journal of Remote Sensing*, *15*(7): 1401-1420.
15. Harper, J. L. (1977). Population biology of plants. Academic Press, London, pp. 892.
16. Harvey, K. R., & Hill, G. J. (2001). Vegetation mapping of a tropical freshwater swamp in the Northern Territory, Australia: a comparison of aerial photography, Landsat TM and SPOT satellite imagery. *International journal of remote sensing*, *22*(15): 2911-2925.
17. Hasmadi, M. I., Zaki, M. H., Adnan, I. A., Pakhriazad, H. Z., & Fadlli, M. A. (2010).Determining and mapping of vegetation using GIS and phytosociological approach in Mount Tahan, Malaysia. *Journal of Agricultural Science*, 2(2): 80.
18. Huete, A. R., Liu, H. Q., Batchily, K. V., & Van Leeuwen, W. J. D. A. (1997). A comparison of vegetation indices over a global set of TM images for EOS-MODIS. *Remote sensing of environment*, *59*(3): 440-451.
19. ISFR (2019). Indian State Forest Report, Forest Survey of India, Dehradun.
20. ISFR (2021). Indian State Forest Report, Forest Survey of India, Dehradun.
21. Jasinski, M. F. (1990). Sensitivity of the normalised difference vegetation index to subpixel canopy cover, soil albedo, and pixel scale. *Remote Sensing of Environment*, *32*(2-3): 169-187.
22. Kumar, M., & Kumar, A. (2015). Phytosociological analysis and diversity of tree species in tropical dry deciduous forest of Indian dry tropics. *Journal of Forestry Research, 26(3): 625-633.*
23. Kumar, R., & Saikia, P. (2020). Forest resources of Jharkhand, Eastern India: socio-economic and bio-ecological perspectives. *Socio-economic and Eco-biological Dimensions in Resource use and Conservation: Strategies for Sustainability*, 61-101.
24. Mani, J. K., & Varghese, A. O. (2018). Remote Sensing and GIS in Agriculture and Forest Resource Monitoring. In: Geospatial Technologies in Land Resources Mapping, Monitoring and Management, Springer, Cham: pp. 377-400.
25. Menon, S., & Bawa, K. S. (1997). Applications of geographic information systems, remote-sensing, and a landscape ecology approach to biodiversity conservation in the Western Ghats. *Current science*: 134-145.
26. Misra, R. (1968). Ecology Workbook Oxford and IBH Publ. Co., New Delhi, pp. 244.
27. Pandey, D. D., Pandey, K., & Kumar, S. S. (2011). Phytosociological studies of grasslands in the vicinity of Pataratu thermal power, Hazaribagh, Jharkhand. *Journal of Phytology*, *3*(12): 63-66.

28. Sahoo, T., Panda, P. C., & Acharya, L. (2017). Structure, composition, and diversity of tree species in tropical moist deciduous forests of Eastern India: a case study of Nayagarh Forest Division, Odisha. *Journal of Forestry Research*, 28(6): 1219-1230.
29. Singh, M., Kumari, N., Sharma, M., Thapliyal, M., & Guleri. (2022) S. Floristic Composition, Species Diversity and Therapeutic Potential Of Plant Resources Of Agricultural Fields Of Shri Guru Ram Rai University, Dehradun, Uttarakhand, India.
30. Singh, R. L. (1971). India: A Regional Geography. National Geographical Society of India,Varanasi, pp. 649.
31. Singh, S., Chand, H. B., Khatri, P. K., Kumar, D., Kewat, A. K., Kumar, A., & Singh, K. P. (2021). Phytosociology and Regeneration Status in Different Permanent Preservation Plots across Different Forest Types in Madhya Pradesh, Central India. *Grassroots Journal of Natural Resources*, *4*(2): 179-198.
32. Sonti, S. H. (2015). Application of geographic information system (GIS) in forest management. *Journal of Geography & Natural Disasters*, *5*(3): 1000145.
33. Sukumar, R., Dattaraja, H. S., Suresh, H. S., Radhakrishnan, J., Vasudeva, R., & Nirmala,S.(1992). Long-term monitoring of vegetation in a tropical. *Current Science*, 62(9): 608-616.
34. Todd, S. W., & Hoffer, R. M. (1998). Responses of spectral indices to variations in vegetation cover and soil background. *Photogrammetric engineering and remote sensing*, *64*: 915-922.
35. Tucker, C. J., & Sellers, P. J. (1986). Satellite remote sensing of primary production. *International journal of remote sensing*, *7*(11): 1395-1416.
36. Turner, W., Spector, S., Gardiner, N., Fladeland, M., Sterling, E., & Steininger, M. (2003). Remote sensing for biodiversity science and conservation. *Trends in Ecology & Evolution, 18*(6): 306-314.